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KSC COST INDEX FOR CONSTRUCTION MANAGEMENT

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SUBJECT: KSC Cost Index for Construction Management

Mr. Joseph A. Brown is presently employed as Construction Cost Engineer for the National Aeronautics and Space Administration's Design Engineering Directorate. In this capacity, he prepares and reviews Government and sub-contractor's construction cost estimates amounting to over \$2 billion for design and construction economies. He evaluates, recommends, coordinates and provides technical management of design engineering projects to accommodate launch vehicles such as Saturn V and Saturn IB for the Apollo and ASTP programs. He is currently working on facility costs and requirements for future space exploration of such programs as the Space Station, Space Shuttle and Viking-unmanned landing on Mars. Mr. Brown received his formal education at the University of Florida where his major study was Architectural and Structural design, estimating, management, supervision and methods & materials. He received an "A of A" and a "BBC" degree there. With the Government, Mr. Brown has completed courses in Management, Procurement, Contract Cost Management, and NASA PERT. He has received a state and county license for Construction Cost Engineering and is a Co-Inventor of Precast Concrete Geodesic Domes. He has done Consulting, Estimating, Quantity Survey and Bidding for General and Sub-Contractors for Commercial, Industrial and Residential Complex Developers-Builders, covering Florida, Georgia, Alabama, & Walt Disney World's Contemporary Resort Hotel. Mr. Brown teaches courses in Civil Engineering Technology at Brevard Community College. He is the Past President and Charter Member of the Florida Section of the American Association of Cost Engineers, AACE 1969 "Member of the Moment", General Arrangements Chairman 1975 AACE Annual Meeting, Society of American Military Engineers, Canaveral Posts "Engineer of the Year." 1973 and NASA Kennedy Space Center's Nominee for "Federal Employee of the Year" 1972. In addition to writing 5 technical papers, in 1972 he was 1st Place Winner in 2 categories in technical writing competition sponsored by the Society of Communications, Central Florida Chapter for "Construction Cost Escalation & Labor Productivity-What We Can Do About It", which was presented at AACE 1st International Symposium in Montreal Canada.

ABSTRACT

Mr. Brown will discuss the Unique Problems of a Remote Location and the Unusual (Exotic) Construction which cause a need for a usable Cost Index to properly evaluate past, present and future projects costs for a more realistic Construction Management of KSC's \$150 million Space Shuttle effort. He will show the Base Index of January 1974 to the latest index available; a Graphic Chart, the Development of the more than 24 material cost items that correspond to the CSI/SPECSINTACT Format, the Labor Base Rate for the 20 Basic Crafts; and the breakdown percentage for each division. Phase II will include the Engineering Cost for the Major Facilities Systems such as steel, concrete, plumbing, air conditioning, electrical, paving & high pressure piping, etc.

This presentation will discuss development of the KSC Construction Cost Index as an aid in achieving effective Construction Cost Management of KSC \$150 million Space Shuttle project. The Cost Index will provide a means for properly evaluating past and present costs and for predicting the impact of cost escalation on facility design and construction. Accurate cost predictions are imperative to ensure that real facility costs remain within the funding allocated by Congress on the basis of conceptual designs and associated budget estimates.

Effective cost management of Shuttle facility projects must overcome the unique problems of KSC's geographical location and requirements for exotic facility systems. Kennedy Space Center is located on the northern portion of Merritt Island, Fla. Nearest labor markets are from 15 to 60 miles away in Orlando, Melbourne, Cocoa, and Daytona Beach. Major materials suppliers and warehouses are located in Tampa, Miami, Jacksonville, and Orlando, at distances varying from 50 to 200 miles from KSC. The additional freight, travel-loss time, and extra warehousing costs result in higher job site costs. Compounding cost increases due to location are costs arising from specialized construction of exotic systems not normally encountered in conventional facilities. KSC facilities require a variety of highly specialized (and hazardous) systems to support launch activities and space vehicle research and development. Exotic systems mean exotic materials and a high number of special skills in the construction and supervision forces. All these factors translate into higher construction costs. Examples of specialized construction include: Uninterruptible Power Supply (UPS), Sterilization Encapsulation Facilities, High Pressure Piping, Hypergolic and Cryogenic Fuel and Oxidizer Systems, highly Sophisticated Clean Rooms for the Assembly and Checkout of Manned and Unmanned Spacecraft for Earth Orbit or Distant Planetary Orbit or Landing, Solid Rocket Motors System, and an extremely complicated Electronic Telemetry Launch Processing System (LPS).

The cost index incorporates price adjustments stemming from the KSC location and specialized construction requirements and informs project estimators and engineers what local labor and material prices are and the rate and amount of change. Price changes are related to a base index of January 1974 and compared to the latest index available. At present the index includes development of the more than 24 Material Cost Items that correspond to the CSI/SPECSINTACT Format, the Labor Base Rate for the 20 Basic Crafts; and the Breakdown Percentage for each division. Price information in the index is given in terms of straight hourly rates for carpenters, masons, and supervisors and in terms of total square-foot costs of standardized KSC facility systems such as structural shell, block walls, plumbing, etc. The square foot cost index for standardized systems may prove to be extremely useful in forecasting costs of specialized systems discussed previously.

As a side benefit, the Cost Index is already proving useful in evaluating estimates prepared by the designated in-house contractor and private A/E firms. In the future, the Index and the forthcoming KSC Standard for Compiling Construction Cost Estimates will aid immensely in identifying and evaluating estimated costs regardless of the methods used to establish them by preparing organizations.

Some of the major Space Shuttle facilities planned, being designed, or in the construction stages are:

1. Orbiter Landing Facility, Phase I & II, 15,000 foot X 300 foot wide by 15" & 16" thick concrete runway plus a 9150 foot tow-away to the VAB and its associated structures and facilities.
2. The Orbiter Processing Facility (Bay 1) Phase I - (Bay 2) Phase II.
3. Vehicle Assembly Building High Bays 3 & 4
4. Mobile Launcher Platform (MLP-1)
5. LC-39 - Launch Pad A
6. Hypergolic Maintenance Facility
7. Solid Rocket Booster Facility
8. Launch Control Center LC-39
9. Approach and Landing Test Facility - Edwards AFB
10. Orbiter Mating Devices, Edwards, Palmdale, and KSC.

Kennedy Space Center is responsible for the Design and Construction of these facilities.

a. KSC's Design Engineering, with over 370 engineers, technicians, managers, etc.

b. PRC - A DE in-house support contractor with over 550 engineers, technicians, managers, etc.

c. Architectural and Engineering Firms from Florida, California, New York, etc., all with varied background, experience and cost engineering information. Since the Space Shuttle Transportation System was conceived in the late 1960's, and the first flight from KSC is scheduled in 1979 or 1980, a great deal of time and Cost Escalation has taken place or will take place. It is especially important in the construction cost management of the \$150,000,000 Shuttle Facility System to obtain the most accurate cost information possible so we can optimize the facilities design within available resources.

With the many facilities required for the Space Shuttle and the more than one thousand design engineers from all over the United States, it is even more important for all involved to have a current cost basis for evaluation of present and future costs at Kennedy Space Center. As described in forthcoming KSC Standard, compilation and coverage of the KSC Cost Index will be as follows: The Index consists of three phases that shall be updated each month. To the extent possible, prices and other required information shall be obtained on the tenth of the month and the Index submitted to the NASA/KSC Cost Engineer prior to the fifteenth of the month. The Index shall be published by the twenty-second day of the month or as directed. An example of a typical KSC Construction Cost Index appears in Appendix A.

(a) Phase I - shall be a compilation of current costs of labor (by trade) and materials in the area local to KSC. Additionally, the amount and rate of change in costs from the previous months shall be indicated in each Index. The composite or job wage rate shall be computed by adding together the base wage, percentage for payroll taxes and insurance, fringe benefits, and applicable travel. Base wages shall be obtained from latest published Department of Labor wage rates for NASA contracts. Material costs shall be based on averaged direct quotes obtained from vendors, suppliers, contractors, and other approved sources, and expressed as cost per unit, using units as specified by the NASA/KSC Cost Engineer. Costs for labor and materials shall be listed by trade in accordance with the organization of SPECSINTACT.

(b) Phase II shall be a continually updated compilation of costs for components that comprise facility systems such as the structural shell, flooring, roofing, exterior and interior walls, plumbing, air conditioning, electrical power and lighting, exterior utilities, high pressure stainless steel piping, fire detection and protection, and others. Component costs shall be priced out by quantity units, labor, material, sales and label taxes and are based on data obtained from current and past projects. Labor costs shall include payroll taxes and insurance, subcontractor overhead, profit and bond, travel and fringe benefits, and prime contractor mark-up as applicable. Component costs shall be adjusted to reflect basic design considerations characteristic of the local area such as wind load factors, interior environmental controls, energy conservation, construction manpower resources and skills, and others related to the intended purpose of the facility. As more and more data is accumulated, Phase II will become an extremely useful tool for cost engineering and management of current and future KSC facility construction projects. The data can be used to develop facility budgets with a higher degree of accuracy than is possible at present.

(c) Phase III shall develop and maintain a KSC Construction Labor Productivity Index for accurately evaluating published cost data and to serve as a guide in compiling more accurate cost estimates for all codes. Phase III should be especially helpful in achieving acceptance and use of a computerized estimating system.

ATTACHMENT A - A Graphic Chart, January 1974 to December 1974

B.- A Detail Material Cost Index for December 1974

C - A Detail Labor Cost Cost Index for December 1974

D - Department of Labor Wage Rates for Brevard County, KSC and PAFB as of November 1974. Shows the base rate, Supervision Payroll Taxes and Insurance, Fringe and Travel

E - Phase II shows a budget cost for some of the major consturction systems used at KSC. Some of the prices may appear to be high because the systems included items not normally estimated in budget designs such as sandblast and inorganiz zinc coating of structural steel and reinforcing steel, formwork, and rubbing and curing of concrete.

F - A cost estimate work sheet for a concrete block wall system with the contractor mark-up for the complete system.

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KSC MATERIAL COST INDEX FOR DECEMBER 1974

SECTION	DIV NAME	MATERIAL	JAN.74 UNIT \$	QUANTITY	DEC.74 UNIT \$	JOB \$
1D	GEN REQ	5/8" PLYWOOD GOS	0.41	200 SF	0.337	67.40
2P	SITEWORK	ASPH PVG 1 1/2" FINE	0.80	30 SY	1.01	30.30
3A	CONCRETE	3000# REDI-MIX	23.25	5 CY	29.20	146.00
		Rebar	0.18	500 LB	0.30	150.00
		Plyform	0.41	250 SF	0.36	90.00
4A	MASONRY	CONCRETE BLOCK 8.8.16-300 SF	0.30	339 EA	0.36	122.04
5B	METALS	TOWER STEEL	1.09	100 LB	1.30	130.00
		Shop Fab Est at	0.86		1.00	
		Installed Est at	0.23		0.30	
5J	METALS	WAREHOUSE SHAPES DELIVERED	0.23	1000 LB	0.35	350.00
6A	CARPENTRY	2" x 4" S4S PINE	0.20	200 BF	0.212	42.40
7M	MOIST PROT	90# ROLL ROOFING	6.90	10 SQ	8.58	85.80
7J	MOIST PROT	FIBER. INSUL 3 1/2" T x 16" W	0.09	1000 SF	0.11	110.00
8G	DOORS	3' x 7' AL/LOCK & FRAME (415.00EA)	114.29	10 SF	19.76	197.60
8J	WINDOWS	3' x 3' AL/FR, SCR & OP/S.H.	22.85	EA	25.95	25.95
9B	FINISHES	VINYL ASBESTOS TILE	0.332	100 SF	0.376	37.60
9C	FINISHES	1/2" GYPSUM BRD	0.0618	1000 SF	0.084	84.00
9D	FINISHES	ACOUSTICAL TILE W/SUSP. SYS	0.33	100 SF	0.50	50.00
10	SPECIALTIES					
11	EQUIPMENT					
12A	FURNISHINGS	VENETIAN BLINDS	1.46	10.5 SF	1.229	12.90
13A	SPEC CONSTR	ELEVATED FLOOR SYS, ALUM	4.34	10 SF	6.75	67.50
14H	CONVEY SYS	FAB & ERECT "I" BEAMS	0.37	100 LB	0.60	60.00
15A	MECHANICAL	CI PIPE CL 150, 6"(\$0.15517 LB)	3.60	25 LF	4.50	112.50
16J	ELECTRICAL	1/2" COPPER TUBING (\$1.667 LB)	0.26	500 LF	0.33	165.00
17C	WELDING	1" WELDED PIPE, 304 SST(\$2.25 LB)	1.85	50 LF	3.78	189.00
18	HVY CONSTRU	CRANE RENTAL (30 TON)	40.00	4 HR	45.00	180.00
19/5K/ 15D	SHEET METAL	.063" ALUM SHEET	0.69	200 LB	0.981	196.20
						<u>\$2702.19</u>

2702.19 x ADJUSTMENT FACTOR OF .493628
 KSC MATERIAL COST INDEX FOR DECEMBER 1974 IS 1334
 33.40% INCREASE OVER JANUARY 1974

SECTION	DIV NAME	CRAFT	JAN.74 BASE \$/HR	DEC.74 BASE \$/HR	JOB \$	% LABOR
1D	GEN COND	LABORER - Common (7.51) Truck Driver (7.68)	6.71	7.60	22.80	3
2P	SITWORK	EQUIP OPERATOR Paving Machine	9.27	10.58	31.74	3
3A	CONCRETE	CEMENT MASON	9.01	10.26	102.60	10
4A	MASONRY	BLOCK MASON CREW 1 Mech 1 Lab	7.97	9.00	90.00	10
5J	METALS	STRUCT IRON CREW 1 Mech 1 Lab	8.92	9.63	144.45	15
6A	CARPENTRY	CARPENTER CREW 1 Mech 2 Lab	8.08	9.02	27.06	3
7M	MOIST PROT	ROOFER	7.37	7.69	30.76	4
8G&J	DOORS & WDWS	CARPENTER CREW 1 Mech 2 Lab	8.08	9.02	27.06	3
9C	FINISHES	PAINTER	9.86	12.02	36.06	3
10	SPECIALTIES	CARPENTER CREW 1 Mech 2 Lab	8.08	9.02	27.06	3
11	EQUIPMENT	STRUCT IRONWORKER	10.90	11.53	69.18	6
12A	FURNISHINGS	CARPENTER CREW 1 Mech 2 Lab	8.08	9.02	27.06	3
13A	SPEC CONSTR	CARPENTER CREW 1 Mech 2 Lab	8.08	9.02	27.06	3
14H	CONVEY SYS	STRUCT IRONWORKER	10.90	11.53	34.59	3
15A	MECHANICAL	PLUMBER CREW 1 Mech 2 Lab	9.26	9.89	49.45	5
16J	ELECTRICAL	ELECTRICIAN CREW 1 Mech 1 Lab	9.38	10.61	106.10	10
17C	PIPE	PLUMBER CREW 1 Mech 1 Lab	9.26	9.89	49.45	5
18	HVY CONSTR	EQUIP OPERATOR Crane	10.09	11.88	35.64	3
19	SHEET METAL	SHEET METAL WORKER	11.92	12.41	62.05	5
					\$1,000.17	100

1,000.17 X ADJUSTMENT FACTOR OF 1.10355
 KSC LABOR COST INDEX FOR DECEMBER 1974 IS 1103
 10.30% INCREASE OVER JANUARY 1974.

DEPARTMENT OF LABOR WAGE RATES FOR NASA CONTRACT PROJECTS

SKILL	RATE	FOREMAN FOR 1/5	GENERAL FOR 1/16	AVERAGE HR. RATE	20% PT&I	FRINGE	TRAVEL	COMPOSITE
BLOCK LAYER	6.26	1.35	.44	8.05	1.61	.60	--	10.26
CARPENTER	7.10	1.52	.50	9.12	1.82	.65	--	11.59
CEMENT FINISHER	6.26	1.35	.44	8.05	1.61	.60	--	10.26
COMMON LABORER	4.50	1.00	.33	5.83	1.17	.51	--	7.51
SKILLED LABORER	4.65	1.03	.34	6.02	1.20	.51	--	7.73
ELECTRICIAN	8.22	1.74	.57	10.53	2.11	.41	.44	13.49
IRON WORKER	6.80	1.46	.48	8.74	1.75	1.04	--	11.53
MILLWRIGHT	7.50	1.60	.52	9.62	1.92	.94	--	12.48
PAINTER	7.65	1.63	.53	9.81	1.96	.25	--	12.02
PIPEFITTER	7.40	1.58	.52	9.50	1.90	.65	--	12.05
ROOFER	4.85	1.07	.36	6.28	1.26	.15	--	7.69
SHEET METAL	7.69	1.64	.53	9.86	1.97	.58	--	12.41
TRUCK DRIVER	4.95	1.09	.36	6.40	1.28	--	--	7.68
CRANE OPERATOR	7.26	1.55	.51	9.32	1.86	.70	--	11.88
BULLDOZER	6.34	1.37	.45	8.16	1.63	.70	--	10.49
PAVING MACHINE	6.41	1.38	.45	8.24	1.65	.70	--	10.58
WELL POINT	6.05	1.31	.43	7.79	1.56	.70	--	10.05
OIL & PUMP	5.40	1.18	.39	6.97	1.39	.70	--	9.06
DUAL AXLE	4.65	1.03	.34	6.02	1.20	--	--	7.22
OFF HIGHWAY	5.10	1.12	.37	6.59	1.32	--	--	7.91

KSC SUPPORT CONTRACTORS USE: \$7.00 PER HOUR FOR MECHANIC
\$4.50 PER HOUR FOR LABORER & TRUCK DRIVER

11 NOVEMBER 1974

JONES:jd

PHASE II COST INDEXBUDGET COST FOR CONSTRUCTION SYSTEMSPRICES AS OF
DECEMBER 11, 1974

THE FOLLOWING ENGINEERING COSTS INCLUDE LABOR, MATERIAL, TAX, INSURANCE, OVERHEAD AND PROFIT. THEY DO NOT INCLUDE DESIGN, ESCALATION, SPECIAL CONDITIONS, OR S&A.

<u>SECT</u>	<u>DIV. NAME</u>	<u>TYPE</u>	<u>COST</u>	<u>UNIT</u>	<u>COST</u>	<u>UNIT</u>
2A	SITE WORK	CLEAR & GRUBB			2000.00	ACR
2D		EXCAVATION - HAND - MACHINE	23.00	CY	5.00	CY
2P		PAVING, RDS & PKG-BASE & EARTHWORK			16.00	SY
3A	CONCRETE	6" SLAB/REBAR & PLYFORM	250.00	CY	4.60	SF
3C		PIERS, BEAMS & COLUMNS, REBAR, FORMS	635.00	CY	24.00	LF
4A	MASONRY	8" BLK WALL-W/INSUL, DRYWALL/PAINT	4.65	BLK	5.60	SF
5A	METALS	STRUCTURAL STEEL - SERVICE STRUCTURE			4000.00	TON
5B		STRUCTURAL STEEL - BUILDING			2600.00	TON
5C		ROOF STRUCT. STEEL			9.00	SF
6C	CARPENTRY	STL.STUD/DRYWALL PART/PAINTING			4.00	SF
7A	MOIST.PROT.	ROOFING/DECK, INSUL, & S.M.			6.50	SF
7A		ROOFING/STEEL FRAMEWORK			15.50	SF
7C		METAL SIDING/INSUL. & DRYWALL			10.00	SF
8A	DOORS	METAL 3 x 7 EXT./PANIC HDW. & FR.			810.00	EA
8A		METAL 3 x 7 INT./HDW. & FR.			570.00	EA
8J	WINDOWS	ALUM/VENETIAN BLINDS 3' x 3' S.H.			16.40	SF
9B	FINISHES	FLOOR TILE VAT 12" x 12"			1.70	SF
9D		ACOUSTIC TILE/2 x 4 SUSPENSION SYS.			1.40	SF
10B	SPECIALTIES	TOILET PARTITION W/HARDWARE			216.00	EA
11	EQUIPMENT					
12	FURNISHINGS	CARPET, PAD & INSTALLATION	21.00	SY	2.35	SF
13A	SPEC.CONSTR.	ELEVATED FLOOR SYSTEM - ALUM.			16.00	SF
14J	CONVEY.SYS.	BRIDGE CRANE-25 TON 100' SPAN- 100' LIFT, EXPLOSION PROOF	370,000.00	EA	14,800.00	TON
15	MECHANICAL					
15A	PLUMBING SYS.-WATER CLOSET FIXTURE & ROUGH-IN				725.00	EA
15C	AIR CONDITIONING - COOLING ONLY		2192.60	TON	10.70	SF
15C&U	AIR CONDITIONING & HEATING		2504.30	TON	12.20	SF
15G	SEWER LINE	VITRIFIED CLAY 6" - 8"	5.15	LF	6.30	LF
15P	FIRE PROTECT.-SPRINKLERS TO 5' LINE		260.00	EA	2.60	SF
15P	HEAT DETECTOR-HADS		272.00	EA	0.68	SF
15R	VENTILATION				0.80	SF
15U	HEATING 164,000 BTU SYSTEM		37.95	MBTU	1.50	SF
15Y	WATER LINE	C.I. PIPE C.L. LAID IN TRENCH 6"-8"	9.55	LF	12.65	LF
15Z	PIPE SST 304 XXS W/SUPPORTS 2" - 4"		96.00	LF	235.00	LF
16	ELECTRICAL					
16G	LIGHTING/POWER PANEL BOARD		4460.00	EA	2.80	SF
16K	3/4" CONDUIT WITH 3 #12 WIRES		3.85	LF	1.00	SF
16N	DUPLEX RECEPTACLE OR SINGLE POLE SWITCH		97.00	EA	2.20	SF
16P	LIGHTING - RECESSED FLUORESCENT FIXTURE		300.00	EA	5.25	SF